ARMSTRONG LABORATORY

AL/HR-TR-1993-0100

AD-A269 483

(2)

THE CONTENT DATA MODEL

Tim Reser

Rob DeDoncker

RJO Enterprises, Inc.
101 Woodman Drive
Dayton, Ohio 45431

Bryan J. Caporlette, 1Lt, USAF

HUMAN RESOURCES DIRECTORATE
LOGISTICS RESEARCH DIVISION
2698 G Street
Wright-Patterson AFB, OH 45433-7604

JULY 1993

FINAL TECHNICAL REPORT FOR PERIOD MARCH 1990 – MARCH 1992

Approved for public release; distribution is unlimited

AIR FORCE MATERIEL COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433-6573

NOTICES

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely Government-related procurement, the United States Government incurs no responsibility or any obligation whatsoever. The fact that the Government may have formulated or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication, or otherwise in any manner construed, as licensing the holder, or any other person or corporation, or as conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

The Public Affairs Office has reviewed this report, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nationals.

This report has been reviewed and is approved for publication.

Bryan J. Caporlette

BRYAN J. CAPORLETTE, 1LT, USAF
Contract Monitor

BERTRAM W. CREAM, Chief
Logistics Research Division

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
July 1993

3. REPORT TYPE AND DATES COVERED
Final - March 1990 to March 1992

4. TITLE AND SUBTITLE
The Content Data Model

5. FUNDING NUMBERS
C - F09603-89-G-0011
PE - 63106F
PR - 2950
TA - 00
WU - 10

6. AUTHOR(S)
Tim Reser
Rob DeDoncker
Bryan J. Caporlette

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
RJO Enterprises, Inc.
101 Woodman Drive
Dayton, Ohio 45431

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Armstrong Laboratory
Human Resources Directorate
Logistics Research Division
2698 G Street
Wright-Patterson AFB, OH 45433-7604

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
AL/HR-TR-1993-0100

11. SUPPLEMENTARY NOTES
Armstrong Laboratory Technical Monitor: Bryan J. Caporlette, AL/HRGO, (513) 255-2606

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

Due to the increasing complexity and number of modern weapon systems, the Air Force faces an ever growing number of paper-based technical orders. The Air Force Armstrong Laboratory, Logistics Research Division has conducted research and development of automated technical information systems. This research investigated technologies for the storage, distribution, and presentation of technical information. Benefits of this research will include improvement of performance of maintenance personnel and reduction in the cost of maintaining Air Force technical information. One of the products of this research includes a technology which provides the Air Force with an economical way of storing technical data. The Content Data Model (CDM) is a specification for a data base which is intended to store all of the technical information for a weapon system. The CDM will facilitate the interchange of technical information contained in Air Force technical orders. This paper presents: (a) a description of the characteristics of the CDM, (b) a detailed description of CDM structure, (c) an explanation of the functionality that CDM data supports, and (d) a description of testing and implementation of the CDM concept.

14. SUBJECT TERMS
computer-aided acquisition logistics support (CALS)
content data model (CDM)
digital technical information
standard generalized mark-up language
type C

15. NUMBER OF PAGES
27

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	SAR

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std Z39-18
298-102

TABLE OF CONTENTS

LIST OF FIGURES

PREFACE

The work described in this paper was performed by RJO Enterprises, Inc., and the U.S. Air Force, Armstrong Laboratory, Logistics Research Division (AL/HRG). The RJO effort was conducted under contract number F09603-89-G-0011/SG0104. The research was designed to support the development of Interactive Electronic Technical Manuals and the Integrated Maintenance Information System efforts being conducted by AL/HRG to improve combat maintenance capability and readiness.

SUMMARY

Due to the increasing complexity and number of modern weapon systems, the Air Force faces an ever growing number of paper-based technical orders. The Air Force Armstrong Laboratory, Logistics Research Division has conducted research and development of automated technical information systems. This research investigated technologies for the storage, distribution, and presentation of technical information. Benefits of this research will include improvement of performance of maintenance personnel and reduction in cost of maintaining Air Force technical information.

One of the products of this research includes a technology which provides the Air Force with an economical way of storing technical data. The Content Data Model (CDM) is a specification for a data base which is intended to store all of the technical information for a weapon system. The CDM will facilitate the interchange of technical information contained in Air Force technical orders.

This paper presents:

- A description of the characteristics of the CDM.

- A detailed description of CDM structure.

- An explanation of the functionality that CDM data supports.

- A description of testing and implementation of the CDM concept.

INTRODUCTION

The aircraft maintenance technician of today faces a challenging task. The technician must interface with several different computer systems on a daily basis and contend with a prolific amount of technical information while performing his/her primary mission--maintenance of a multi-million-dollar weapon system. He/she may have to access flight data, either from crew members or through the flight data recorder; select and utilize the appropriate technical orders for maintaining the system; perform the various diagnostics required to repair the system; order the appropriate parts from supply to fulfill his/her mission; record data generated as a result of the maintenance action; and receive training to stay proficient in his/her skills. The systems with which the technician must interface include the Core Automated Maintenance System (CAMS), Comprehensive Engine Management System (CEMS), Standard Base Supply System (SBSS), any automated training systems, and possibly others. These automated systems exist as "Islands of Information". Each system operates autonomously and must be accessed differently.

The Armstrong Laboratory, Logistics Research Division (AL/HRG), is developing a prototypical maintenance system that poses a solution to this "Islands of Information" problem. This system is the Integrated Maintenance Information System (IMIS) [Link87]. The intent of IMIS is to provide technicians with a single point where they may access all of these various types of information (Figure 1).

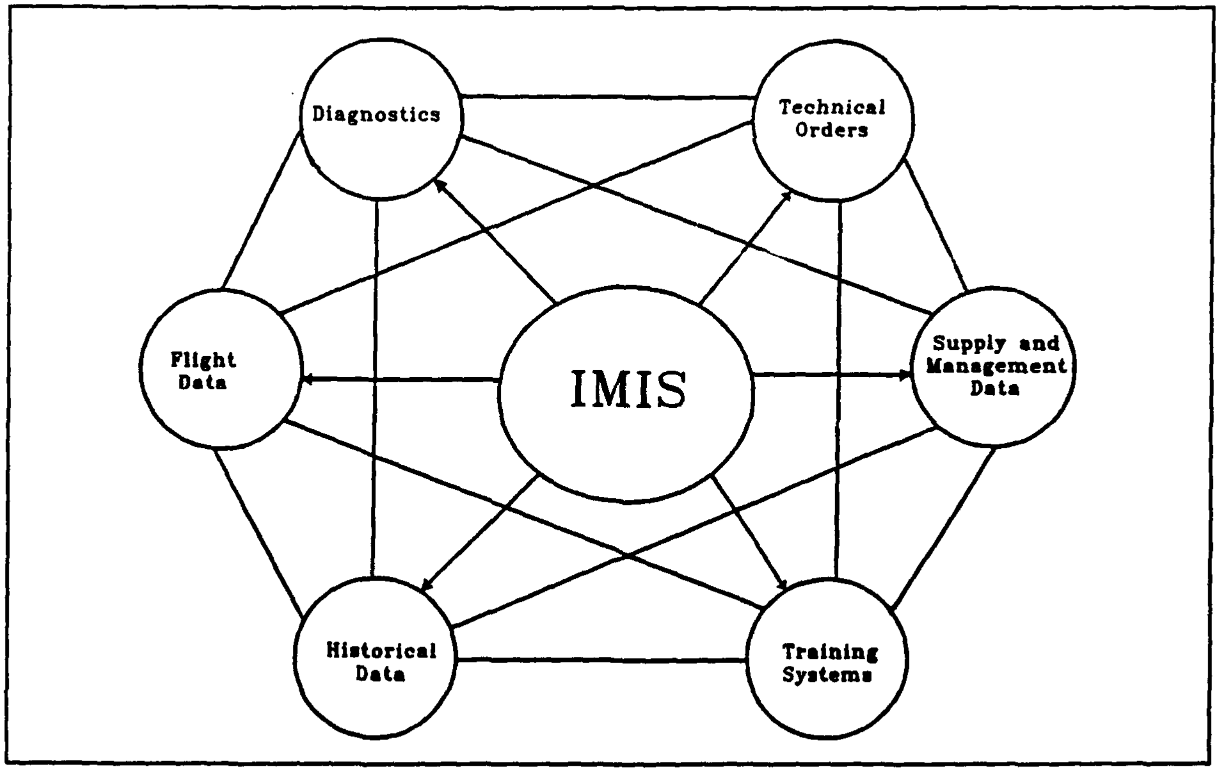

Figure 1. Integrated Maintenance Information System

One of the most important types of information an aircraft technician needs to access is technical manual data. To automate the authoring and display of technical manuals, certain technical advances in data presentation, data development, and data representation were required. During early phases of the IMIS program, the need for these advancements was recognized. The resulting concept under continuing development and research by AL/HRG, with support from RJO Enterprises, Inc., is a new method of developing and representing technical manual data, the Content Data Model (CDM). This paper provides a brief description of the CDM and its role in an integrated maintenance information system.

BACKGROUND

Within the last few years, as a matter of convenience and to promote a better understanding of the direction the technical manual environment is taking, categories have been developed into which technical manuals can be placed depending on their intended use and how they are/were developed, distributed, and presented. These categories have been labeled A, B, and C. Each category has associated with it certain characteristics that differentiate it from the others.

Type A, B, and C Data

The evolution of technical manuals is depicted in Figure 2. In the past, technical manuals were created and used via a paper medium (hard copy). The format and structure of these

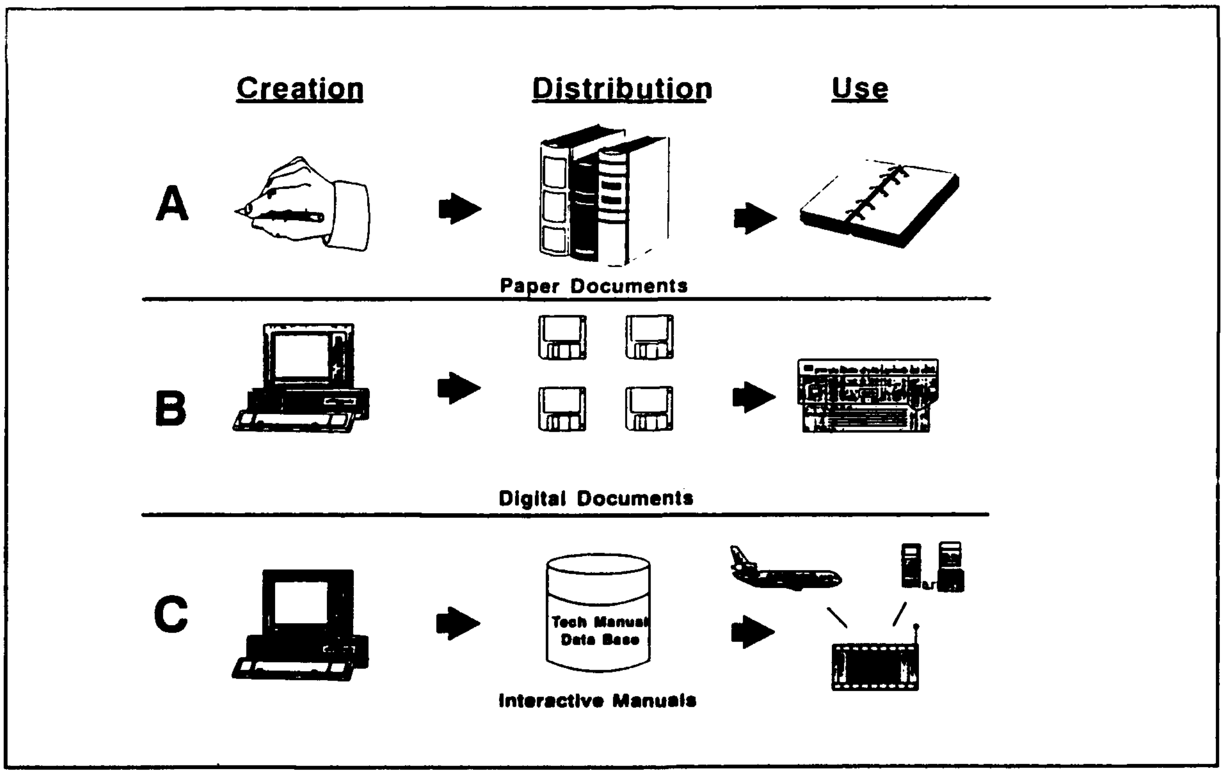

Figure 2. Evolution of Technical Manuals

documents were determined by their medium. The category Type A is used to designate a manual authored, delivered, and used on paper. As technology matured, different ideas for the presentation and creation of technical manuals appeared. The advent of the computer allowed for a more efficient method of authoring the manuals. Additionally, distribution and update of these documents was made easier by storing the technical manuals and change pages on magnetic media. These data are designated as category B. Although digitally created and stored, Type B documents are still page-oriented. They are essentially electronic page-turners that require huge amounts of storage space on an electronic system. Type B documents can be displayed electronically or on paper. Additional capabilities are possible with a more advanced database approach. Type C technical manuals provide these capabilities. Type C documents are authored in an electronic environment, utilize an interactive database, are nonredundant, and can be presented either electronically or on paper. The CDM is the first model to embrace the features of a Type C document.

The Content Data Model and Type C Characteristics

CDM based data has other unique characteristics that distinguish it from Type A or B data. These characteristics include the way the CDM (or any Type C document) handles display media, data primitives, tagging, data organization, and dynamics (see Figure 3).

	B	C
Display Media	Paper	Electronic
Data Primitives	Text, Tables, Graphics	Text, Tables, Graphics, Audio, Video Process
Tagging	Limited Format Tagging Structure Tagging	No Format Tagging Content Tagging
Data Organization	Redundant Elements Non-Integrated Files Cross Referencing	Non-Redundant Referencing Integrated Database Relational Links
Dynamics	Versioning No User Interaction	Context Dependent Filtering User Interaction & Branching
	Static Presentation	Dynamic Presentation

NOTE: B+ data is B data which has been enhanced by any, but not all, of the type C characteristics.

Figure 3. Type B vs. Type C Data Characteristics

Display Media. Type C data is designed primarily for electronic display, however, paper display can be rendered as well. Type B data is a page-oriented display; therefore, it is a static display. Type B data contains formatting information typically suited for display on a specific configuration of a designated computer system. Type C data, however, does not contain formatting information and can be presented on a variety of computer systems, given appropriate software. Type C uses an electronic display which allows for the presentation of technical manuals in a dynamic, task-oriented environment.

Data Primitives. Data Primitives are the "building blocks" of technical information. In a paper-based document, text, tables, and any associated graphics are combined to convey an idea, such as a maintenance step or theory of operation explanation. A Type C database allows for additional data primitives. These additional primitives include audio or video information and other software processes. The ability of a Type C database to communicate the necessary information to the technician is enhanced by its ability to incorporate these additional data primitives.

Tagging. Tagging refers to the way information contained within a document can be labeled. This information can be labeled in several different ways, including format, structure, and content.

Format Tagging. Type B documents developed on computer systems generally contain embedded format information that deals with the manner in which that technical information is to be presented. This format information contains such presentations rules as font type, whether a particular title is to be bold-faced, centered vs. left-justified, or start on a new page. In a Type C database, this information is external to the data.

Also, formatting rules are often machine-dependent. That is, the specific code required to center a piece of text on one computer may not be the same on a computer by a different manufacturer. Separating the format from the actual information creates a "neutral" database that is machine-independent. Type C data does not contain formatting information; therefore, it is neutral and machine-independent.

Structure Tagging. Paper-based documents can be readily divided into the various parts that comprise the document. For example, a technical paper may have sections which contain first-level paragraphs which may contain lower-level paragraphs. Type B documents utilize this inherent structure of paper-based documents (see Figure 4). When tied to the formatting rules described previously, this provides an efficient method of authoring, reproducing, and distributing Type B data. However, since the information modelled in this fashion is still page oriented, redundancy in the data still exists. This increases the costs associated with the update and storage of electronic technical manuals developed in this fashion.

Content Tagging. Type C data is identified not by the structure of the document in which it resides, but rather its content. For example, a group of sentences which may have been identified as a Level 1 paragraph under the structure tagging concept may now be identified as a task element. A task element contains information necessary to complete a maintenance task. Other lower-level paragraphs may be identified as steps. A step element contains instructions for one step in a task. Figure 5 depicts the concept of content tagging. Content

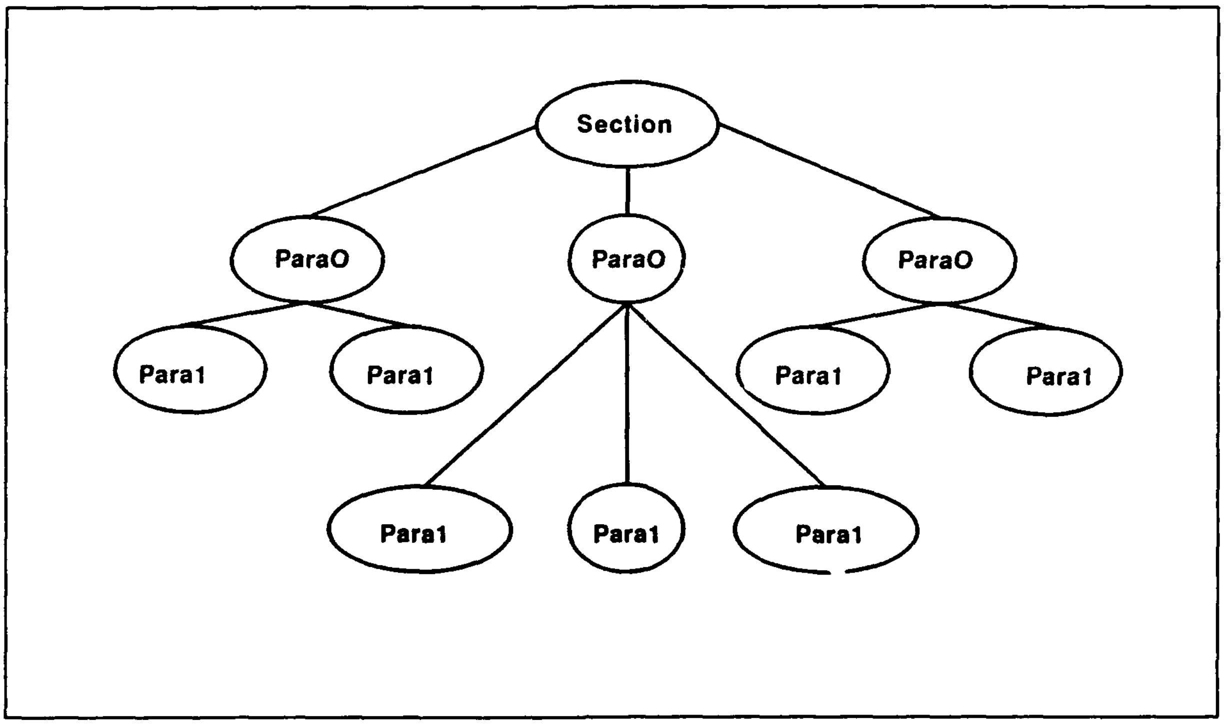

Figure 4. Structure Tagging

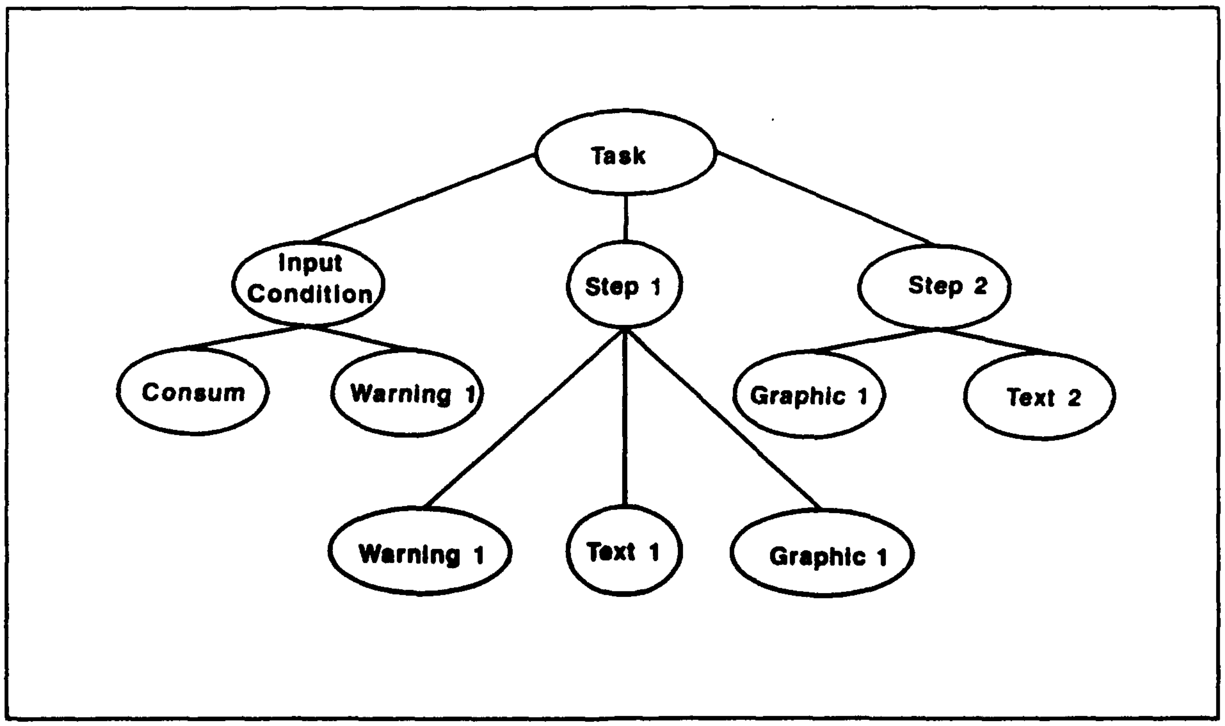

Figure 5. Content Tagging

tagging begins building intelligence into the data, which allows the development of advanced presentation systems that can interpret the tags and display the correct information.

Data Organization. Type C data has advanced data-organization techniques. These features include nonredundant referencing and the capability to provide relational links. These concepts are further explained below.

Nonredundant Referencing. In paper-based documents (such as Type B documents), the same warning may appear in several manuals or several times in the same manual. This information is physically stored in the electronic document every time it is used. Because this information is stored many times, any required changes to the information must be made in every place that specific piece of information exists. This is a challenging configuration management task which dramatically increases the effort and costs associated with updating technical manuals. A Type C database eliminates this data redundancy by storing each piece of information only once. References to each specific piece of information are stored so that information can be used many times. Changes to the database need only be made once for all uses of the information to be updated. Figure 6 graphically depicts the concept of nonredundant referencing. Warning 1 "belongs" to Step 1; however, it is being referenced by the Input condition. Graphic 1 is being referenced by Step 2.

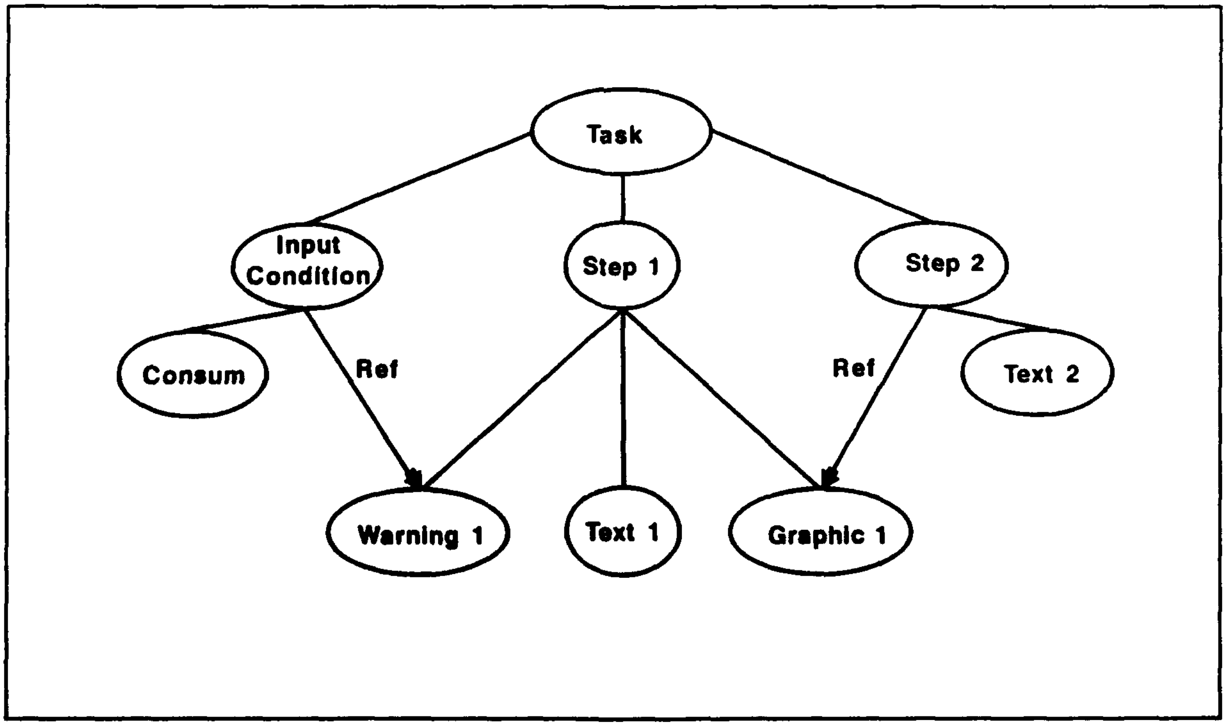

Figure 6. Nonredundant Referencing

Relational Links. The ability to access additional information related to a particular task, step, or maintenance procedure (such as theory of operation) in a paper-based technical manual is accomplished by flipping pages, accessing other manuals, or both. Type C data, on the other

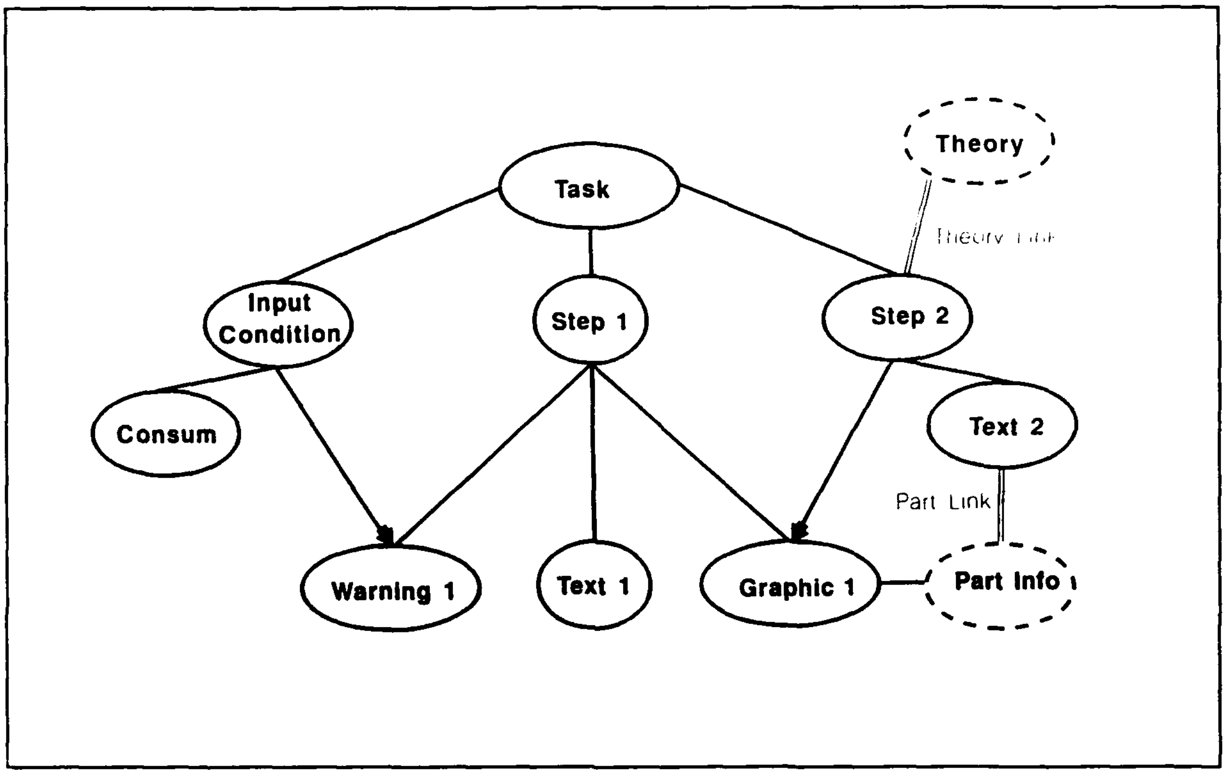

Figure 7. Relational Links

hand, allows for this ability through "relational links." Within the database, identifiers are established that allow one piece of information to "link out" to other, supporting information. Generally, the information being linked to is not directly required for the task at hand. When a link is activated, the information on the electronic display is replaced by the linked information. When completed, the original information is returned to the display and the presentation continues from that point. Figure 7 depicts the concept of relational links. Step 2 links to Theory Information that supports that particular step. Text 2 links to Part Info. In both cases, the information being linked is supporting information not directly relevant to performing the task.

Dynamics. The CDM database contains features that provide for the dynamic presentation of information. Dynamic presentation is defined as "presentation of the technical information on an electronic screen such that the information presented is determined by user response or interaction." Paper-based technical information is statically displayed. Context-dependent filtering allows presented information to be tailored based on specific run-time parameters. User interaction and branching gives the user control during the presentation period.

Context-Dependent Filtering. Current paper-based technical manuals present information which may or may not be applicable to the situation; the user must decide what information is relevant, e.g. find the information specific to the model of aircraft he/she is working on. A powerful feature of a Type C data base is the ability for the system to present to the user only the

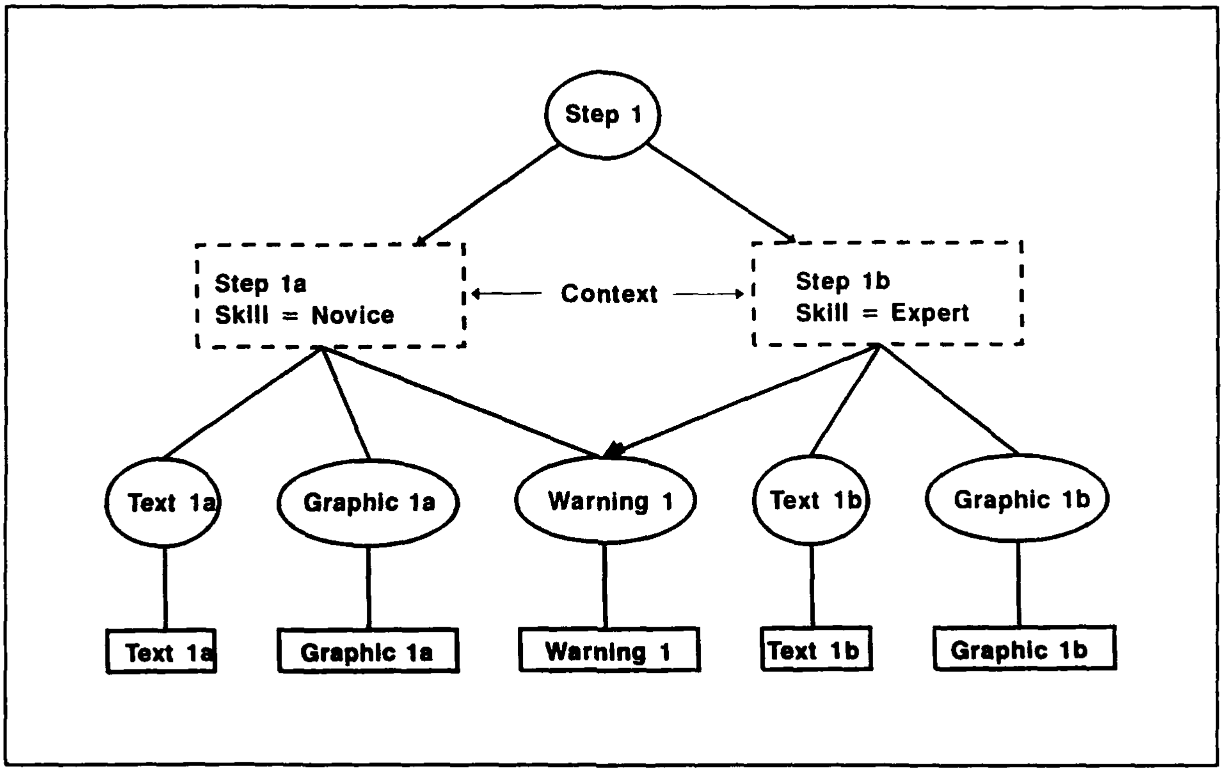

Figure 8. Context-Dependent Filtering

information which applies to his/her current situation. For example, a novice technician would see information different from that presented to an expert technician. In the paper environment, the technician performing the task chooses those steps relevant to his current scenario. A Type C database and corresponding presentation system can automatically accomplish this filtering and present to the user only the applicable information. Context-dependent filtering is graphically depicted in Figure 8.

User Interaction and Branching. Type C databases allow for interaction with the user. The user provides feedback to the system in the form of answers to questions which the system has presented to the user. This provides the ability to present different information to the user based on his/her response to a question or prompt. For example, a technician troubleshooting a system on an aircraft is prompted by the computer to apply power to a circuit and measure the voltage. If the voltage is above 15 volts, one action is to be performed; if it is below 15 volts, some other action is to be taken. The presentation system will ask the technician whether the voltage as tested was above or below 15 volts. The technician will respond to the system using one of the various interaction schemes available. The system can then present the appropriate subsequent maintenance steps based on this response. Figure 9 shows this scenario.

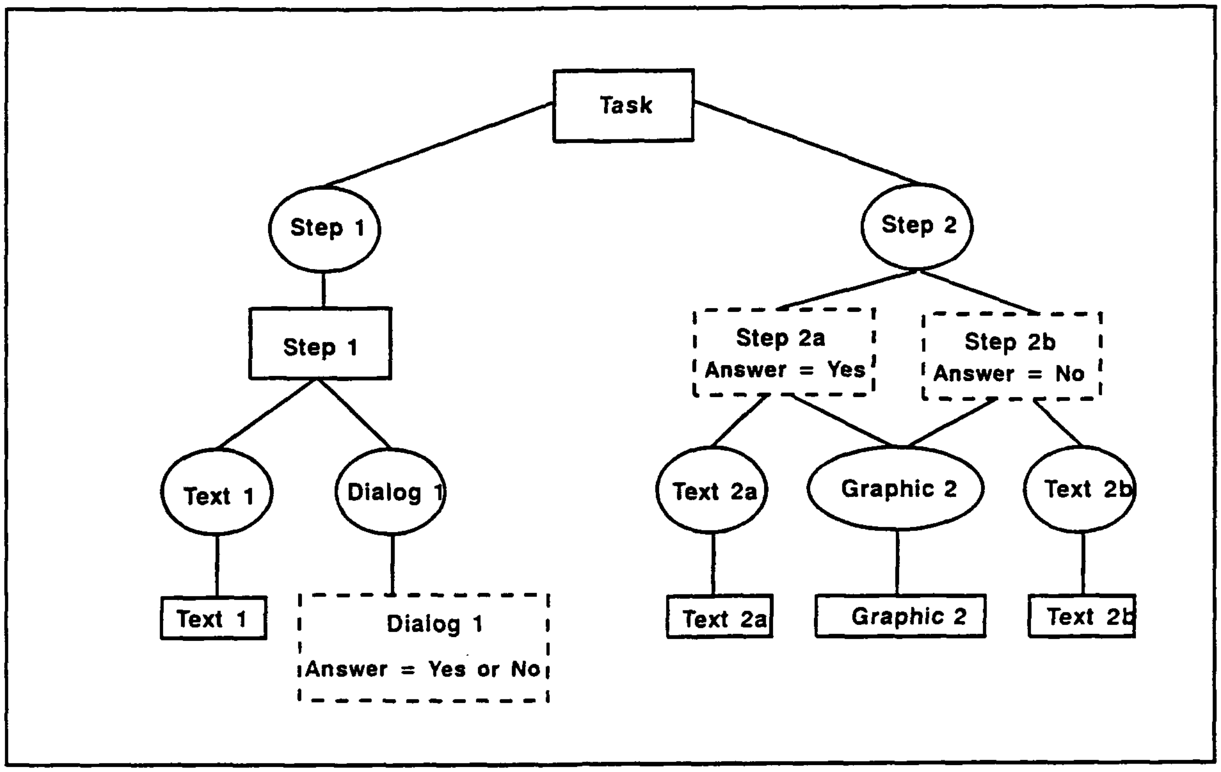

Figure 9. User Interaction and Branching

GENERIC LAYER

The CDM has been under development for several years to provide a model for defining the characteristics of Type C data for the Department of Defense. In early 1990, CDM Version 5.3 was released for industry review. CDM 5.3 was a hierarchically based data model of technical information. That is, it was based on the system/subsystem/subassembly hierarchy found within a weapon system. A previous technical paper details much of the work performed toward building interactive electronic technical manuals (IETMs) based on CDM 5.3 [Freese90].

Further research, along with comments from Government and industry, resulted in the identification and improvement of some shortcomings in the earlier version. First, CDM 5.3 attempted to model all elements necessary for a technical information database. Although CDM 5.3 provided a good model of organizational-level data, it could not identify all the elements which may be required for future weapon systems. Second, the data characteristics previously described in this technical paper as Type C characteristics, were not readily discernible in

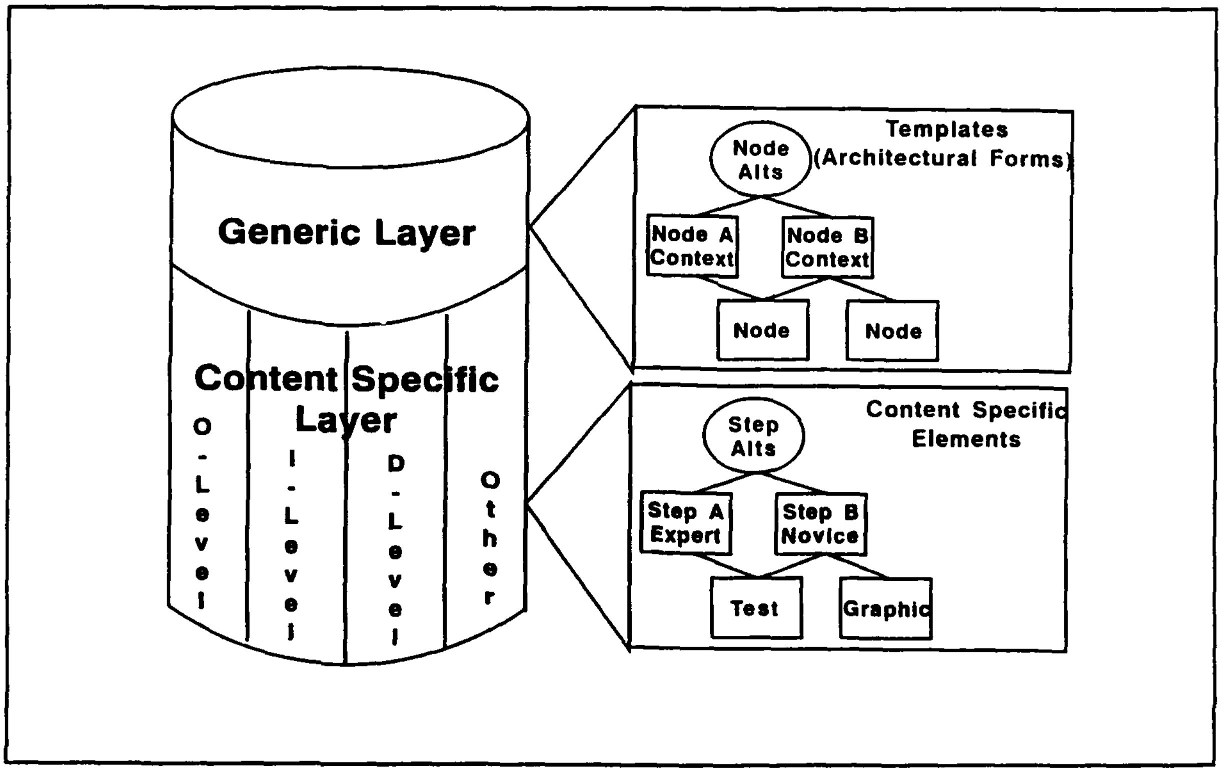

Figure 10. CDM Two-Layer Approach

discernible in CDM 5.3. Although the complete functionalities of these C characteristics were present, it was difficult to see how they were defined and recognize their power in the IETM environment. CDM 6.0 corrects these problems by employing a two-layered approach to define technical information. The top layer, called the Generic Layer, defines the semantic rules for Type C data characteristics. The bottom layer, called the Content-Specific Layer, employs the Generic Layer when defining elements for weapon-system-specific technical information (see Figure 10). The Generic Layer explicitly describes the CDM data characteristics in one central location. It does this by defining data primitives and templates.

Primitives

As mentioned earlier, primitives are the basic building blocks of a technical information database. Defining the data primitive elements in the Generic Layer provides consistency across various weapon system content-specific implementations. In addition to the basic text, table, graphic, audio, video, and process primitives, other user interaction, branching, and context filtering elements (e.g. dialogs, expressions, assertions) are also defined in the generic layer.

It is sometimes necessary to receive data from the user in order to present the proper information at the proper time. Dialog elements provide a means for user interaction; the three basic elements are menu, fill-in, and selection. The menu element allows for the construction of a menu through which the user can select one or more options. The fill-in element allows the user to assign a value to a property by answering a question. The selection element allows the creation of a special dialog that permits selection within a given picture, text, or table.

Templates

Templates are Standard Generalized Markup Language (SGML) element models that define a set of semantic rules to be used when creating application-specific elements. The author must use the templates to define new application-specific elements, attributes, and relationships. By employing the templates, the author is assured that the element definitions provide all the functionality prescribed for Type C data. This ensures these characteristics remain constant among different content-specific applications. Also, defining the semantic rules in the Generic Layer provides a solid foundation for developing presentation and authoring system software. Five templates are defined in the Generic Layer to provide flow control in presenting information: node template, node-alt template, node-seq template, if-node template and loop-node template. These five templates define different semantic rules which must be followed when creating content-specific document type definitions (DTDs) in accordance with the generic layer.

Node. The node template provides the structure for creating composite data units of technical information and contains the pieces of technical information. Each node may have associated with it a pre- and/or postcondition. A precondition is an expression that must evaluate to true before a node is presented to the technician. A postcondition contains an assertion which is used to update the current "state" of the system whenever it is altered.

Node-alt. The node-alt template provides for context-dependent filtering of a collection of nodes. Although the node-alt references many nodes, only one node will be used by the presentation system. The current maintenance context determines which node is presented. The others are not applicable and, therefore, do not get displayed. This process is accomplished through the use of preconditions. Each node referenced in the node-alt has an associated precondition. When a precondition evaluates to true, its associated node is presented.

Node-seq. The node-seq template contains many nodes. These nodes are presented in a specified order; this allows the author to control the presentation order of a group of nodes. For example, the node-seq template would be employed if the author wanted to specify a certain sequence of steps within a task.

If-node. The if-node provides the structure for creating branching logic within the technical information and allows the selection of one node-seq versus another depending on an author-defined condition.

Loop-node. Loop-node provides a grouping of nodes that can be executed repeatedly until a specified condition is met.

Node Attributes. Attributes can be associated with SGML elements to qualify or uniquely identify an element. The Generic Layer of the CDM specifies certain required attributes for elements defined using its templates: the "cdm" attribute and the "ref" attribute.

CDM Attribute. In the Generic Layer, each template contains a "cdm" attribute. This attribute identifies which template a content-specific element employs and indicates the node type to a presentation system. The "cdm" attribute also allows an element to "inherit" the characteristics provided by the template it uses. This is the primary method through which enforcement of the semantic rules for a Generic Layer template are applied. For example, if a content-specific element identifies the element as type NODE, the element must follow the rules established by the NODE template in the Generic Layer.

Ref Attribute. The "ref" attribute reduces data redundancy by allowing an element to reference a previously defined node of the same type. The "ref" attribute utilizes the SGML #CONREF capability. A #CONREF attribute is only filled in when the content model of the element is empty. In this case, the #CONREF attribute contains a reference which is a unique identifier to either an element of the appropriate type or a location element that resolves to an element of the appropriate type. When an element uses the #CONREF capability, the attribute list of the referencing element will take precedence over that of the referenced element.

Other Attributes. The use of the other node attributes (e.g., "name", "type", and "itemid") are defined by the content-specific element that uses the node template.

CONTENT SPECIFIC LAYER

The content-specific layer DTD contained in the current release of the IETM Database (IETMDB) specification (MIL-D-87269) was developed for organizational-level maintenance. The model follows the system/subsystem/subassembly hierarchy of weapon systems (Figure 11). Four types of information are available at each level of the hierarchy: procedural, fault, descriptive, and part information.

Procedural Information

Procedural information includes all tasks which can be performed on a given system (remove, replace, adjust, etc.). These types of elements guide the technician's actions during the maintenance session.

Fault Information

Fault information elements describe the tests, faults, and rectifications associated with components. They are used to isolate the faulty components and provide the technician with the correct repair procedure.

Descriptive Information

Descriptive information includes all nonprocedural information, such as theory of operation, wiring diagrams, schematics, etc. This type of information can be used by a technician who has little experience on a specific system and desires additional knowledge.

Parts Information

Parts information provides the data necessary to order a part from supply or create an illustrated parts breakdown.

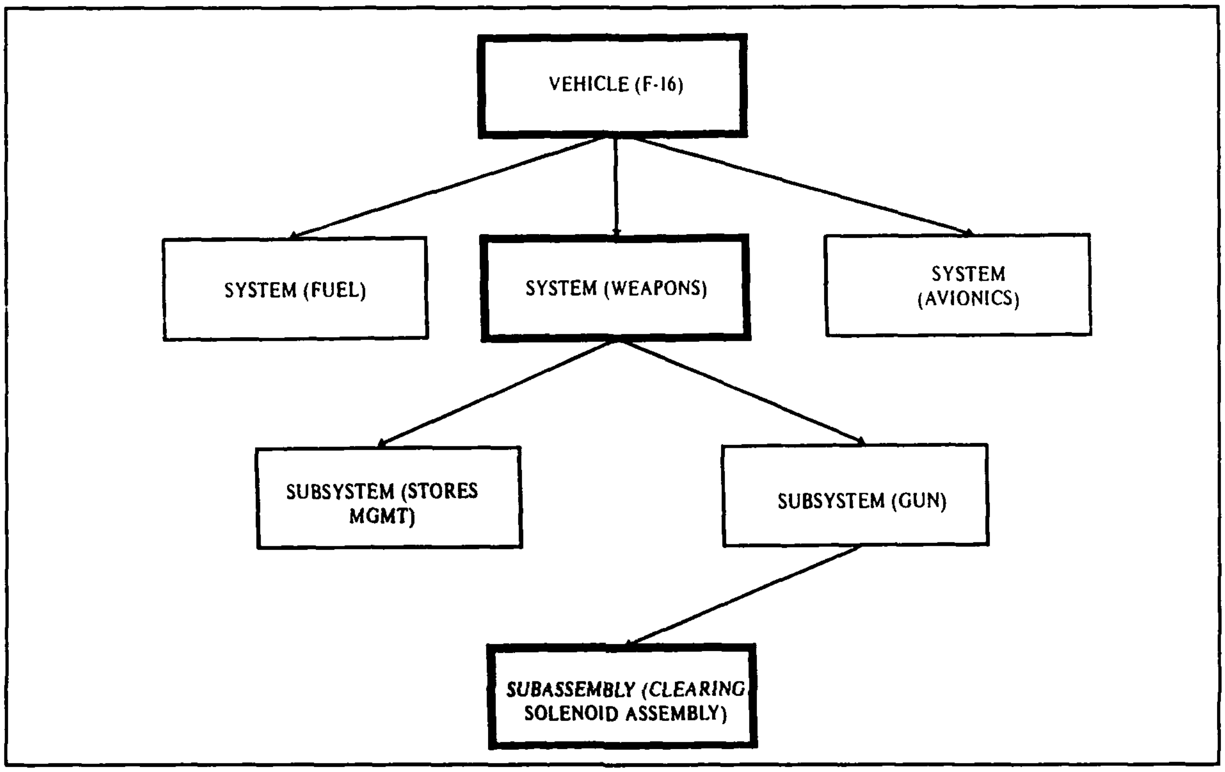

Figure 11. System/Subsystem Hierarchy

TESTING AND IMPLEMENTATION

AL/HRG recently undertook an IETM field test and demonstration project, using the CDM to represent technical manual data for the F/A-18 aircraft. A CDM-based authoring system and presentation system, as well as several Portable Maintenance Aids (PMAs), were developed and brought to Marine Corps Air Station (MCAS), Beaufort, S.C, for three weeks of testing in June, 1992. The field test proved the capabilities of the CDM for representing data, and also proved the validity of the entire IETM concept [Thomas92].

OTHER PROGRAM IMPLEMENTATIONS

The Content Data Model has been proven to meet the needs of the Air Force as a method of developing and representing technical data in a neutral fashion. Based on this, an entire suite of IETM specifications [MIL-M-87268, MIL-D-87269, MIL-Q-87270] have been formally published as of 20 November 1992. Currently, there are several Department of Defense programs working to develop IETM systems for their particular weapon systems. Among these

IETM programs are the F-22 Advanced Tactical Fighter (ATF) Integrated Maintenance System (AIMS), the JSTARS Computerized Technical Order System (CTOS), and the V-22 Osprey Technical Information System (OTIS), a joint Air Force/Navy/Marine Corps program. All of these programs are in various stages of using the CDM to develop technical data to be used in an IETM system. The F-22 AIMS program will be a full-up implementation of the IMIS concept and will be the first weapon system to utilize all three IETM specifications.

SUMMARY

The continuing research performed under this task resulted in the identification and improvement of some shortcomings in earlier CDM versions. Although the complete functionalities of Type C data characteristics were present, it was difficult to see how they were defined and recognize their power in the IETM environment. CDM 6.0 corrects these problems by employing a two-layered approach to define technical information. The top layer, called the Generic Layer, defines the semantic rules for Type C data characteristics. The bottom layer, called the Content-Specific Layer, employs the Generic Layer when defining elements for weapon-system-specific technical information. The Generic Layer explicitly describes the CDM data characteristics in one central location.

ACRONYMS

AL/HRG	Armstrong Laboratory, Logistics Research Division
AIMS	Advanced Tactical Fighter Integrated Maintenance System
ATF	Advanced Tactical Fighter
CAMS	Core Automated Information System
CEMS	Comprehensive Engine Management System
CDM	Content Data Model
DoD	Department of Defense
DTD	Document Type Definition
IETM	Interactive Electronic Technical Manual
IETMDB	Interactive Electronic Technical Manual Database
IMIS	Integrated Maintenance Information System
SBSS	Standard Base Supply System
SGML	Standard Generalized Markup Language
SPO	System Program Office

REFERENCES

Freese90. Freese, Eric, et al, RJO Enterprises, Inc. Content Data Model: Technical Summary. AFHRL-TP-90-10. May 1990.

Link87. Link, William R., Capt. USAF, et al. Integrated Maintenance Information System (IMIS): A Maintenance Information Delivery Concept. AFHRL-TP-87-27. November 1987.

MIL-M-87268. Military Specification. MIL-M-87268. Manuals, Interactive Electronic Technical: General Content, Style, Format, and User-Interaction Requirements. 20 November 1992.

MIL-D-87269. Military Specification. MIL-D-87269. Data Base, Revisable: Interactive Electronic Technical Manuals, for the Support of. 20 November 1992.

MIL-Q-87270. Military Specification. MIL-Q-87270. Quality Assurance Program: Interactive Electronic Technical Manuals and Associated Technical Information; Requirements for. 20 November 1992.

Thomas92. Thomas, D., et al. Draft Technical Report. Integrated Maintenance Information System (IMIS) F/A-18 Interactive Electronic Technical Manual (IETM) Diagnostic Demonstration. AL-TR-1992-XXXX.

U.S. G.P.O.: 1993-750-061/81004